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Sea Surface Salinity spectra: a validation tool for satellite, numerical simulations and in-situ data

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Satellite Remote sensing measurements are used in oceanography since the mid-1970s. Thanks to satellite imagery, the research community has been able to better interpret surface structures, such as meandering fronts or eddies, which became apparent in instantaneous views of the ocean. Moreover, satellite altimeter and sea surface temperature (SST) observations evidenced the high percentage of ocean energy accumulated at the intermediate scales (tens to hundreds of km, days-weeks), i.e. the oceanic mesoscale. Today, thanks to the launch of the Soil Moiture and Ocean Salinity (SMOS) mission (2009) and the Aquarius mission (2011), we have more than four years of satellite-derived Sea Surface Salinity (SSS) observations with the objectives of improving seasonal and interannual climate prediction, ocean rainfall estimates and hydrologic budgets, and monitoring large-scale salinity events and thermohaline convection (Lagerloef, 2001).
A study from Reynolds and Chelton (2010) compared six different SST products using spatial power density spectra in three regions of the ocean at different periods (January and July 2007-2008). The results showed that the spatial spectra vary geographically and temporally, and from one product to the next. Here, a similar study is presented for the first time with SSS data to help understand the spatial signature of the SSS variability and validate the different data sources. Thanks to the increased maturity of remote sensing estimations of SSS, the spatial spectra of the SSS fields provided by numerical models can now be compared with observations. In this work, we focus on the region of North Atlantic Ocean for the year of January and July of 2011 and 2012. The data used in this work come from Satellites (AQUARIUS and/or SMOS Level 2), outputs of an ocean model (NEMO-OPA, configuration DRAKKAR-NATL025), in-situ observations collected during the Barcelona World Race (BWR 2010), and the climatology of Levitus (WOA09).
The results show that the grid spacing does not always correspond to the actual spatial resolution of the SSS fields. Also, a noise floor is clearly seen in the satellite-derived SSS spectra below 150-200 km scales. Model SSS fields typically resolve less variability than satellite SSS at intermediate scales, notably during the initial period of the model run. The BWR (in-situ) is the only source that resolves small scale variability and presents no sign of a noise floor. These results open the grounds for an objective validation of SSS data, in which proper characterization of the spatial scales resolved by the different data sources is required (Stoffelen, 1998).

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